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Controlled growth of mollusc shells: quantitative crystallographic texture analysis input

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Mollusc shells exhibit very complex ultrastructures, combinations of variously ordered organic and mineral phases, in which the mineral phase growth is controlled by the organic matrix. In order to understand this controlled growth, many x-ray investigations of shell focussed on the intrinsic organic-mineral link inside individual crystallites. However, few studies tried to reveal how individuals are linked to each others. Quantitative Texture Analysis (QTA) is an x-ray methodology that probes the overal growth of a shell at the mm or cm scale. It can then give hints on the growth development, which is also controlled by organic material.

We illustrate in this work what quantitative texture analysis can bring on the understanding of the macroscopic-microscopic link. For instance comparing different macroscopic organisation (Haliotis versus Pinctada or Nautilus species) of very closely shaped individual 6-folded nacre crystallites. We show to what extent the organic material can modify the natural growing of calcite or aragonite, and how the different layers composing a shell are organised to each other.

QTA inputs on phylogeny, medecine and palaeontology are also examplified. New views for the non-ancestral character of nacre are deduced. However, QTA data on mollusc conform as an overal to the historically sketched diagrams of molluscs, but significant texture variations among species are observed which undoubtedly can bring new insights. For instance, when solely the crystalline part of extinct species remains, e.g. fossils for which no genetic information is accessible, texture diagrams can deserve to complete the phylogeny. Using modern x-ray combined approaches on laboratory instruments we demonstrate how we can determine both the macroscopic parameters like texture and simultaneously mean microscopic characteristics like crystallite shapes. Finally perspectives are made on how to calculate macroscopic mechanical properties of single layers from QTA experiments.